IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Andreas Norbert Wiswesser, et al.
Serial No. : Unknown
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Title : METHOD AND APPARATUS FOR DETERMINING POLISHING ENDPOINT WITH MULTIPLE LIGHT SOURCES

Art Unit : Unknown
Examiner : Unknown

Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Prior to examination, please amend the application as follows:

In the Title:

Please delete the current Title and insert the following:

--METHOD AND APPARATUS FOR DETERMINING POLISHING ENDPOINT WITH MULTIPLE LIGHT SOURCES--

In the specification:

At page 1, line 6, insert the following paragraph:

--The present application is a continuation of U.S. Patent Application Serial No. 09/237,472, filed January 25, 1999.--

In the claims:

Cancel claims 24-33, 35 and 46-54.

Amend claims 1, 36, 43, 45 and 58 as follows:

1. (Amended) An apparatus for use in chemical mechanical polishing a substrate, comprising:

a first optical system including a first light source to generate a first light beam to impinge on the substrate, the first light beam having a first effective wavelength, and a first

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sensor to measure light from the first light beam that is reflected from the substrate to generate a first signal;

a second optical system including a second light source to generate a second light beam that impinges the substrate, the second light beam having a second effective wavelength which differs from the first effective wavelength, and a second sensor to measure light from the second light beam that is reflected from the substrate to generate a second signal; and

a processor configured to determine a polishing endpoint from the first and second signals.

2. The apparatus of claim 1, wherein the first and second light beams have different wavelengths.

3. The apparatus of claim 1, wherein the first and second light beams have different incidence angles on the substrate.

4. The apparatus of claim 3, wherein the first and second light beams have different wavelengths.

5. The apparatus of claim 1, wherein the first effective wavelength is greater than the second effective wavelength.

6. The apparatus of claim 5, wherein the first effective wavelength is not an integer multiple of the second effective wavelength.

7. The apparatus of claim 1, wherein at least one of the optical systems is an off-axis optical system.

8. The apparatus of claim 7, wherein both the first and second optical systems are off-axis optical systems.

9. The apparatus of claim 7, wherein the first optical system is an off-axis optical system and the second optical system is a normal-axis optical system.

10. The apparatus of claim 1, wherein at least one of the optical systems is a normal-axis optical system.

11. The apparatus of claim 1, wherein at least one of the first and second light sources is a light emitting diode.

12. The apparatus of claim 11, wherein the first light source is a first light emitting diode having a first coherence length and the second light source is a second light emitting diode having a second coherence length.

13. The apparatus of claim 12, wherein the first coherence length is greater than a optical path length of the first light beam through a layer in the substrate, and the second coherence length is greater than an optical path length of the second light beam through the layer in the substrate.

14. The apparatus of claim 1, further comprising a polishing pad which contacts the first surface of the substrate.

15. The apparatus of claim 14, further comprising a platen to support the polishing pad, wherein the platen includes an aperture, and the first and second light beams pass through the aperture.

16. The apparatus of claim 14, further comprising a platen to support the polishing pad, wherein the platen includes a first aperture and a second aperture, and the first light beam passes through the first aperture and the second light beam passes through the second aperture.

17. The apparatus of claim 14, wherein the polishing pad includes a transparent window, and the first and second light beams pass through the window.

18. The apparatus of claim 14, wherein the polishing pad includes a first transparent window and a second transparent window, and the first light beam passes through the first window and the second light beam passes through the second window.

19. The apparatus of claim 1, wherein the first effective wavelength is greater than the second effective wavelength.

20. The apparatus of claim 19, wherein the first light beam has a first wavelength and the second light beam has a second wavelength that is shorter than the first wavelength.

21. The apparatus of claim 20, wherein the first wavelength is between about 600 and 1500 nanometers.

22. The apparatus of claim 20, wherein the second wavelength is between about 300 and 600 nanometers.

23. The apparatus of claim 19, wherein the first light beam has an incidence angle on the substrate that is less than a second incidence angle of the second light beam on the substrate.

34. An apparatus for use in chemical mechanical polishing a substrate having a first surface and a second surface underlying the first surface, comprising:

a first optical system including a first light source to generate a first light beam to impinge on the substrate, the first light beam having a first effective wavelength, and a first sensor to measure light from the first light beam that is reflected from the first and second surfaces to generate a first interference signal; and

a second optical system including a second light source to generate a second light beam that impinges the substrate, the second light beam having a second effective wavelength which

differs from the first effective wavelength, and a second sensor to measure light from the second light beam that is reflected from the first and second surfaces to generate a second interference signal.

36. (Amended) An apparatus for use in chemical mechanical polishing a substrate, comprising:

a first optical system including a first light emitting diode to generate a first light beam that impinges the substrate, the first light beam having a first effective wavelength, and a first sensor to measure light from the first light beam that is reflected from the substrate to generate a first signal; and

a second optical system including a second light emitting diode to generate a second light beam that impinges the substrate, the second light beam having a second effective wavelength that differs from the first effective wavelength, and a second sensor to measure light from the second light beam that is reflected from the substrate to generate a second signal.

37. The apparatus of claim 36, wherein the first light beam has a first wavelength and the second light beam has a second wavelength that is shorter than the first wavelength.

38. The apparatus of claim 37, wherein the first wavelength is between about 700 and 1500 nanometers.

39. The apparatus of claim 37, wherein the second wavelength is between about 300 and 700 nanometers.

40. The apparatus of claim 36, wherein the substrate has a layer in a thin film structure disposed over a wafer, and wherein the first and second light beams have coherence lengths sufficiently large to maintain coherence of the first and second light beams as they pass through the layer.

41. The apparatus of claim 40, wherein a first coherence length of the first beam is greater than an optical path length of the first light beam through the layer, and a second coherence length of the second light beam is greater than an optical path length of the second light beam through the layer.

42. An apparatus for detecting a polishing endpoint during chemical mechanical polishing of a substrate having a layer in a thin film structure disposed over a wafer, the substrate having a first surface and a second surface underlying the first surface, comprising:

a light emitting diode to generate a light beam that impinges the layer of the substrate, wherein the light beam emitted by the light emitting diode has a coherence length equal to or greater than the optical path length of the light beam through the layer;

a sensor to measure light from the light beam that is reflected from the first and second surfaces to generate an interference signal; and

a processor configured to determine the polishing endpoint from the interference signal.

43. (Amended) An apparatus for detecting a polishing endpoint during chemical mechanical polishing of a substrate, comprising:

a first optical system including a first light source to generate a first light beam having a first effective wavelength that impinges the substrate, and a first sensor to measure light from the first light beam that is reflected from the substrate to generate a first signal; and

a second optical system including a second light source to generate a second light beam that impinges the substrate, the second light beam having a second effective wavelength that differs from the first effective wavelength, and a second sensor to measure light from the second light beam that is reflected from the substrate to generate a second signal; and

a processor configured to combine the first and second signals and detect the polishing endpoint.

44. An apparatus for measuring a thickness during chemical mechanical polishing of a substrate having a first surface and a second surface underlying the first surface, comprising:

means for generating first and second light beams having different effective wavelengths to impinge on the substrate;

means for detecting light from the first and second light beams that is reflected from the first and second surfaces to generate a first and second interference signals; and

means for determining a thickness from the first and second interference signals.

45. (Amended) A method of determining a layer thickness for a substrate undergoing chemical mechanical polishing, comprising:

generating a first signal by directing a first light beam having a first effective wavelength onto the substrate and measuring light from the first light beam reflected from the substrate with a first detector;

generating a second signal by directing a second light beam having a second effective wavelength onto the substrate and measuring light from the second light beam reflected from the substrate with a second detector, wherein the first effective wavelength differs from the second effective wavelength; and

determining the polishing endpoint from the first and second interference signals.

55. The method of claim 45, wherein the first and second light beams have different wavelengths.

56. The method of claim 45, wherein the first and second light beams have different incidence angles on the substrate.

57. The method of claim 56, wherein the first and second light beams have different wavelengths.

58. (Amended) A method of detecting a polishing endpoint during polishing of a substrate, comprising:

generating a first signal by directing a first light beam having a first effective wavelength onto the substrate and measuring light from the first light beam reflected from the substrate;

generating a second signal by directing a second light beam having a second effective wavelength onto the substrate and measuring light from the second light beam reflected from the substrate, wherein the first effective wavelength differs from the second effective wavelength; and

combining the first and second signals to determine a polishing endpoint.

REMARKS

Attached is a marked-up version of the changes being made by the current amendment.

Applicant asks that all claims be examined.

Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: 5/8/01

David Goren

David J. Goren
Reg. No. 34,609

Telephone: (650) 322-5070
Facsimile: (650) 854-0875

Correspondence Address:

Patent Counsel
Legal Affairs Department, M/S 2061
APPLIED MATERIALS, INC.
P.O. Box 450A
Santa Clara, CA 95052

Version with markings to show changes made

In the specification:

At page 1, line 6, the following paragraph has been inserted:

--The present application is a continuation of U.S. Patent Application Serial No. 09/237,472, filed January 25, 1999.

In the claims:

Claim 1-33, 35 and 43-58 have been cancelled.

Claims 1, 36, 43, 45 and 58 have been amended as follows:

1. (Amended) An apparatus for use in chemical mechanical polishing a substrate, [having a first surface and a second surface underlying the first surface,] comprising:

a first optical system including a first light source to generate a first light beam to impinge on the substrate, the first light beam having a first effective wavelength, and a first sensor to measure light from the first light beam that is reflected from the [first and second surfaces] substrate to generate a first [interference] signal;

a second optical system including a second light source to generate a second light beam that impinges the substrate, the second light beam having a second effective wavelength which differs from the first effective wavelength, and a second sensor to measure light from the second light beam that is reflected from the [first and second surfaces] substrate to generate a second [interference] signal; and

a processor configured to determine a [thickness] polishing endpoint from the first and second [interference] signals.

36. (Amended) An apparatus for use in chemical mechanical polishing a substrate, [having a first surface and a second surface underlying the first surface,] comprising:

a first optical system including a first light emitting diode to generate a first light beam that impinges the substrate, the first light beam having a first effective wavelength, and a first

sensor to measure light from the first light beam that is reflected from the [first and second surfaces] substrate to generate a first [interference] signal; and

a second optical system including a second light emitting diode to generate a second light beam that impinges the substrate, the second light beam having a second effective wavelength that differs from the first effective wavelength, and a second sensor to measure light from the second light beam that is reflected from the [first and second surfaces] substrate to generate a second [interference] signal.

43. (Amended) An apparatus for detecting a polishing endpoint during chemical mechanical polishing of a substrate, [having a first surface and a second surface underlying the first surface,] comprising:

a first optical system including a first light source to generate a first light beam having a first effective wavelength that impinges the substrate, and a first sensor to measure light from the first light beam that is reflected from the [first and second surfaces] substrate to generate a first [interference] signal; and

a second optical system including a second light source to generate a second light beam that impinges the substrate, the second light beam having a second effective wavelength that differs from the first effective wavelength, and a second sensor to measure light from the second light beam that is reflected from the [first and second surfaces] substrate to generate a second [interference] signal; and

a processor configured to [compare] combine the first and second [interference] signals and detect the polishing endpoint.

45. (Amended) A method of determining a layer thickness for a substrate undergoing chemical mechanical polishing, comprising:

generating a first [interference] signal by directing a first light beam having a first effective wavelength onto the substrate and measuring light from the first light beam reflected from the substrate with a first detector;

generating a second [interference] signal by directing a second light beam having a second effective wavelength onto the substrate and measuring light from the second light beam

reflected from the substrate with a second detector, wherein the first effective wavelength differs from the second effective wavelength; and

determining the [thickness] polishing endpoint from the first and second interference signals.

58. (Amended) A method of detecting a polishing endpoint during polishing of a substrate, comprising:

generating a first [interference] signal by directing a first light beam having a first effective wavelength onto the substrate and measuring light from the first light beam reflected from the substrate;

generating a second [interference] signal by directing a second light beam having a second effective wavelength onto the substrate and measuring light from the second light beam reflected from the substrate, wherein the first effective wavelength differs from the second effective wavelength; and

[comparing] combining the first and second [interference] signals to determine a polishing endpoint.